Data Analysis, Action & Evaluation

Analysis involves looking at data and trying to explain or understand what you've found. Often, collection of data over time reveals patterns and trends that are extremely useful in data analysis. Using graphs may help you see and understand these patterns. Tips on creating graphs are provided on pages 98-100.

It is important to remember that the data you have collected are interrelated – habitat evaluation helps to explain macroinvertebrate presence, which depends upon chemical parameters, etc. A simple but important question is: Do my results make sense? If not, what does not fit? How can this be explained? The following are useful questions to ask during data analysis:

- Are there any noticeable patterns? (See graphing information on pages 98-99)
- How do my results compare to the Indiana average values and typical ranges? (See Appendix D)
- What does macroinvertebrate sampling reveal that is not reflected in chemical testing? (See page 101)
- Do the results indicate sources of pollution in the watershed? (See page 102-104)
- Do the test results seem to correlate to land use? (See page 104-105)
- Do the CQHEI, Pollution Tolerance Index, and Water Quality Index scores agree? (See page 106)

Take Action

List any problems that you discovered during sampling. You may decide that you want to help resolve a problem that you have identified. First, you must define who or what is affected by the problem. For example, *E*. coli bacteria contamination impacts the stream community and is a threat to human health.

Second, determine the possible actions that you could take. You may choose to educate others by speaking to neighbors, at school, or by writing to the newspaper. You may choose to take direct action by making lifestyle changes, organizing a stream cleanup, or planting vegetation to stabilize steam banks. You may even consider taking political action by speaking at a public meeting or by writing or visiting public officials.

Third, create an action plan comprised of the actions you feel will best help solve the problem. Your plan needs to be realistic and achievable with available information, have a designated time frame, and yet still be challenging and interesting to you and your group. Work locally with people in your community.

Finally, implement your plan. Divide tasks among group members and interested participants and set timelines for each step, as well as an overall deadline. Record meetings and monitor your progress. We encourage volunteers to use their data to take action at a local level.

Evaluate the River Study

Evaluation of your river study is important, as it helps to identify successes and improve future monitoring efforts. Consider whether or not you were able to meet the goals you set prior to beginning stream monitoring. Was time a major limitation? Did you take on too many sampling sites? Did you feel comfortable using the equipment, or would another Hoosier Riverwatch training workshop be helpful? What did you learn? If you developed an action plan, was it successful?

In evaluating your stream or river study, you will likely come up with additional questions. Feel free to contact the Hoosier Riverwatch office, as we want to help with the continued success of your volunteer monitoring project and the statewide volunteer stream monitoring program.

*Concepts in this chapter were modified from the GREEN Standard Water Monitoring Kit Manual. The process is detailed in the Earth Force-GREEN publication: *Protecting Our Watersheds* - more information available in Appendix F-1.

Downloading Your Data

You can download your data and nearly all the information stored in the Hoosier Riverwatch Volunteer Stream Monitoring Internet Database. SEARCH the database by watershed, county, stream or river name, organization name, volunteer ID#, and which datasheets (flow, habitat - CQHEI, chemical, or biological) - and at the bottom of the page click on "Download to a csv file". Your data will be saved in a comma-delimited format, which can be opened in a spreadsheet program.

Open your file in a spreadsheet programs (like Excel™, Lotus 1-2-3™, and Quattro Pro™). Be sure not to use a word processing program (Word™ or WordPerfect™) because data isn't easily managed in these programs. You can then use your spreadsheet program to create graphs.

Data Analysis and Presentation Using Graphs

(Information from EPA Volunteer Stream Monitoring: A Methods Manual)

Analyzing and presenting numerical data is very difficult using tables filled with numbers. Graphs and charts are one of the best ways to summarize your findings and show the bottom line for each site (e.g., is it good or bad) and seasonal and year to year trends.

Graphs and Charts - Graphs can be used to display the summarized results of large data sets and to simplify complicated issues and findings. The three basic types of graphs that are typically used to present volunteer monitoring data are: Bar graph, Line graph, and Pie chart. Bar and line graphs are typically used to show results (such as phosphorus concentrations) along a vertical or y-axis for a corresponding variable (such as sampling date or site) which is marked along the horizontal or x-axis. These types of graphs can also have two vertical axes, one on each side, with two sets of results shown in relation to each other and to the variable along the x-axis.

Bar Graph - A bar graph uses columns with heights that represent the value of the data point for the parameter being plotted. Figure 24 is an example using fictional data from Volunteer Creek.

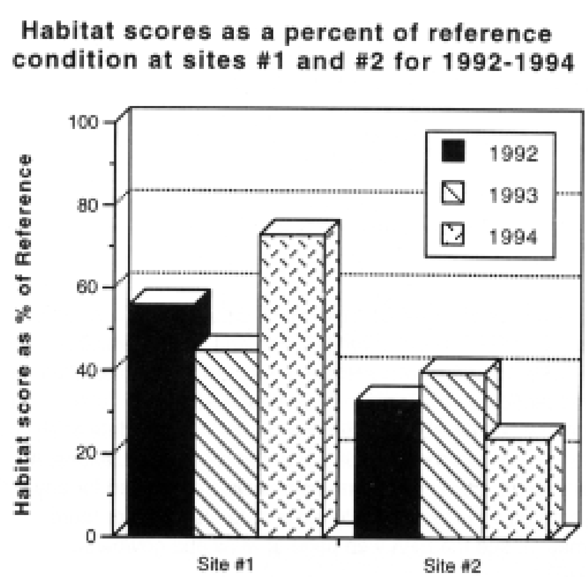
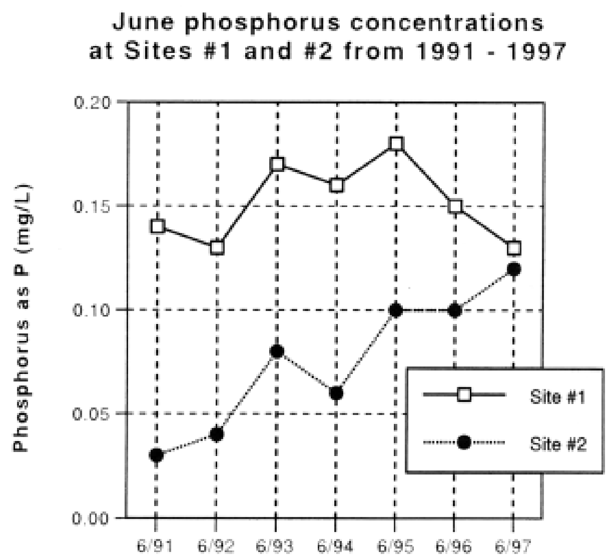


Figure 24

Example of a bar graph displaying habitat data

Line Graph - A line graph is constructed by connecting the data points with a line. It can effectively be used for depicting changes over time or space. This type of graph places more emphasis on trends and the relationship among data points and less emphasis on any particular data point. Figure 25 is an example of a line graph again using fictional data from Volunteer Creek.

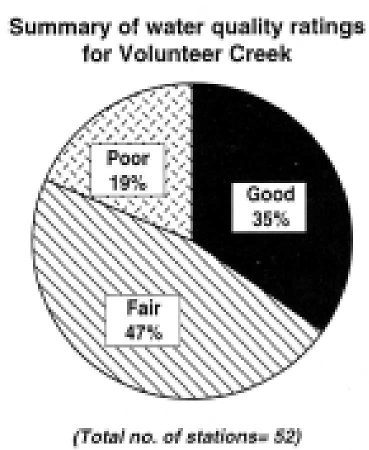
Figure 25



Example of a line graph displaying trends in phosphorus data

Pie Chart - Pie charts are used to compare categories within the data set to the whole. The proportion of each category is represented by the size of the wedge. Pie charts are popular due to their simplicity and clarity. (See Figure 26)

Figure 26



Example of a pie chart summarizing water quality ratings

Graphing Tips

Regardless of which graphic style you choose, follow these rules to ensure you can utilize your graphics most effectively.

* Each graph should have a clear purpose. The graph should be easy to interpret and should relate directly to the content of the text of a document or the script of a presentation.

* The data points on a graph should be proportional to the actual values so as not to distort the meaning of the graph. Labeling should be clear and accurate and the data values should be easily interpreted from the scales. Do not overcrowd the points or values along the axes. If there is a possibility of misinterpretation, accompany the graph with a table of the data.

* Keep it simple. The more complex the graph, the greater the possibility for misinterpretation.

* Limit the number of elements. Pie charts should be limited to five or six wedges, the bars in a bar graph should fit easily, and the lines in a line graph should be limited to three or less.

* Consider the proportions of the graph and expand the elements to fill the dimensions, thereby creating a balanced effect. Often, a horizontal format is more visually appealing and makes labeling easier. Try not to use abbreviations that are not obvious to someone who is unfamiliar with the program.

* Create titles that are simple, yet adequately describe the information portrayed in the graph.

* Use a legend if one is necessary to describe the categories within the graph. Accompanying captions may also be needed to provide an adequate description of the elements.

Habitat Parameters for Selected Macroinvertebrates*

pH Ranges for Selected Macroinvertebrates*

TAXA	1 2 3 4 5 6 7 8 9 10 11 12 13 14
mayfly	XXXX
stonefly	XXXX
caddisfly	XXXX
snails	XXXXXXXXX
clams	XXXXXXXXX
mussels	XXXXXXXXX

* pH ranges 1-6 and 10-14 are unsuitable for most organisms.

Temperature Ranges for Selected Macroinvertebrates

TAXA	Cold Range < 12.8°C	Middle Range 12.8 - 20°C	Warm Range >20°C
caddisfly	X	X	X
stonefly	X	X	
mayfly	X		
water pennies	X		
water beetles		X	
water striders		X	
dragonfly		X	X

Minimum Dissolved Oxygen Levels for Selected Macroinvertebrates

TAXA	High Range 8-10 ppm	Medium Range 4-8 ppm	Low Range 0-4 ppm
stonefly	X		
water penny	X		
caddisfly	X	X	
some mayflies	X	X	
dragonfly		X	
true bugs		X	
damselfly		X	
mosquito			X
midges			X
pouch snail			X
rat-tailed maggot			X

* The values provided are preferred ranges for most species of these groups of organisms.

From GLOBE Manual 1997.

PHYSICAL CONDITIONS

MAKING WATER QUALITY CONNECTIONS

PHYSICAL CONDITIONS OBSERVED	POSSIBLE ASSOCIATED PROBLEMS	POSSIBLE ASSOCIATED CAUSES
WATER APPEARANCE		
Green, Green-Blue, Brown or Red	Indicates the growth of algae	High levels of nutrient pollution, originating from organic wastes, fertilizers, or untreated sewage
Muddy, Cloudy	Indicates elevated levels of suspended sediments, giving the water a muddy or cloudy appearance	Erosion is the most common source of high levels of suspended solids in water Land uses that cause soil erosion include mining, farming, construction, and unpaved roads
Dark Reds, Purple, Blues, Blacks	May indicate organic dye pollution	Originating from clothing manufacturers or textile mills
Orange-Red	May indicate the presence of copper	Copper can be both a pollutant and naturally occurring Unnatural occurrences can result by acid mine drainage or oil-well runoff
Blue	May indicate the presence of copper, which can cause skin irritations and death of fish	Copper is sometimes used as a pesticide, in which case an acrid (sharp) odor might also be present
Foam	May indicate presence of soap or detergent	Excessive foam is usually the result of soap and detergent pollution Moderate levels of foam can also result from decaying algae, which indicates nutrient pollution
Multi-Colored (oily sheen)	Indicates the presence of oil or gasoline floating on the surface of the water. Oil and gasoline can cause poisoning, internal burning of the gastrointestinal tract and stomach ulcers	Oil and gasoline pollution can be caused by oil drilling and mining practices, leaks in fuel lines and underground storage tanks, automotive junk yards, nearby service stations, wastes from ships, or runoff from impervious roads and parking lot surfaces
No Unusual Color	Not necessarily an indicator of clean water	Many pesticides, herbicides, chemicals, and other pollutants are colorless or produce no visible signs of contamination
ODORS		
Sulfur (rotten eggs)	May indicate the presence of organic pollution	Possible domestic or industrial wastes
Musty	May indicate presence of organic pollution	Possible sewage discharge, livestock waste, decaying algae, or decomposition of other organic pollution
Harsh	May indicate presence of chemicals	Possible industrial or pesticide pollution
Chlorine	May indicate the presence of over-chlorinated effluent	Sewage treatment plant or a chemical industry
No Unusual Smell	Not necessarily an indicator of clean water	Many pesticides and herbicides from agricultural and forestry runoff are colorless and odorless, as are many chemicals discharged by industry
EROSION	Sediment and suspended solids	Land uses that cause soil erosion include mining, farming, construction, unpaved roads, and deforestation
DUMPING	Decomposition of organic material or humanmade products, presence of chemical or metal pollutants in water, presence of oil or gasoline in water	Construction, urbanization
DISCHARGE PIPES	Organic wastes, detergents, chemical/industrial runoff, sewage, temperature increase in body of water	Improper industrial waste treatment, improper sewage or gray water treatment

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MAKING WATER QUALITY CONNECTIONS

WATER QUALITY CONDITIONS

EARTH FORCE GREEN (Global Rivers Environmental Education Network)

WATER QUALITY CONDITIONS OBSERVED	POSSIBLE ASSOCIATED PROBLEMS	POSSIBLE ASSOCIATED CAUSES
DECREASE IN DISSOLVED OXYGEN	Temperature increase	Reduction in vegetation shading body of water; increase in sediment or suspended solids; industrial cooling processes
	Organic waste — once part of a living plant or animal (food, leaves, feces, etc.)	Leaking or failing septic systems; waste from farms and animals (pets and feedlots); discharge from food-processing plants, meat-packing houses, dairies, and other industrial sources; garbage; industrial waste (organic fibers from textile, paper, and plant processing); sewage treatment plants, natural processes; grass, tree, and shrub clippings; urban runoff; agricultural runoff
	Chemical runoff — herbicides, pesticides, insecticides	Golf courses; residential lawns; agricultural lands; recreational parks
	Trash	Litter washed into sewer systems
	Lack of algae and rooted aquatic plants	Multiple sources of water pollution (e.g., chemicals, toxins)
	Low water levels	Climatic or weather change
FECAL COLIFORM BACTERIA *E. COLI* ENTEROCOCCI	Organic waste — feces from human beings or other warm-blooded animals	Leaking or failing septic systems; failing sewer systems
		Direct discharge from mammals and birds with access to waterways or waste entering a body of water as runoff
INCREASE IN TEMPERATURE (THERMAL POLLUTION)	Organic waste — once part of a living plant or animal (food, leaves, feces, etc.)	Natural processes; grass clippings; tree and shrub clippings; unnatural fish or animal kills
	Reduction in vegetation shading body of water	Shade trees and shrubs removed from stream bank for urban development, irrigation, and industrial and agricultural expansion, exposing the water to direct sunlight
	Industry and power plant discharge	Water returned to source is at higher temperature than at initial intake point
	Runoff from warmed urban surfaces	Impervious land cover such as paved streets, sidewalks, and parking lots
		Urbanization leading to increased numbers of buildings, homes, and roads on lands, that previously were natural areas and absorbed rain and snowmelt more efficiently
	Suspended solids	Removal of streamside vegetation; overgrazing; poor farming practices and construction causing excessive soil erosion
	Flow of water impeded	Dams, dikes, and diversions for agricultural, industrial, or municipal practices decrease flow rate of river, absorbing more heat from sunlight
		Dams created from beavers or log jams
TURBIDITY HIGH TOTAL DISSOLVED SOLIDS/ TOTAL SOLIDS	Suspended solids (ranging from clay, silt, and plankton, to industrial wastes and sewage)	Erosion from agricultural fields; construction sites; residential driveways, roads, and lawns; natural and accelerated erosion of stream bank; excessive algae growth
		Leaves and plant materials
		Wastewater treatment plant
		Runoff from urban areas
		Dredging waterways
		Waste discharge (garbage, sewage)
		Excessive population of bottom-feeding fish (such as carp) that stir up bottom sediments
EXCESSIVE PHOSPHATES	Human wastes	Leaking or failing septic systems; sewage treatment plants
	Organic waste — once part of a living plant or animal (food, leaves, feces, etc.)	Waste containers leaking; lack of waste storage facilities; animals have direct access to waterways
		Pet wastes not collected and disposed of appropriately
		Removal of natural vegetation for farming or construction practices, causing soil erosion
		Draining swamps and marshes for farmland or commercial/residential development
		Drained wetlands no longer functioning as filters of silt and phosphorous
	Runoff from fertilized land	Agricultural fields; residential lawns; home gardens; golf courses; recreational parks
	Industrial waste	Poorly treated sewage; broken pipes; farms; golf courses; sewage treatment facilities; industrial discharges
	Detergents	Household and commercial cleaning agents washing into water and sewage systems
	Natural events	Forest fires and fallout from volcanic eruptions
EXCESSIVE NITRATE	Runoff from fertilized land	Agricultural fields; residential lawns; golf courses; recreational parks
	Human wastes	Leaking or failing septic systems; sewage treatment facilities
	Animal wastes	Waste containers leaking; lack of waste storage facilities; animals (particularly ducks and geese) that have direct access to waterways
		Pet wastes not collected and disposed of appropriately
	Organic waste — once part of a living plant or animal (food, leaves, feces, etc.)	Natural processes; grass clippings; tree and shrub clippings; unnatural fish or animal kills
PH	Vehicles for transportation	Improper engine maintenance of vehicles (emissions systems)
	Industrial waste	Industrial or mining drainage; sewage treatment plants
	Runoff from fertilized land	Agricultural fields; residential lawns; golf courses; recreational parks
PH & ALKALINITY	Acid rain (beginning in neighboring regions)	Excessive air pollution from burning fossil fuels for automobiles, boats, planes, etc.
SALINITY	Salt and oil runoff	Paved roads cannot absorb substances, such as salts used on roads in winter; irrigation water picks up salts in soil
	Bodies of salt water mixing with fresh water	Water tables decrease in areas where water is being pumped (used) at levels exceeding replenishment capability
HIGH CONDUCTIVITY	Discharges into the water	Failing sewage systems
		High temperature
		Water used for irrigation
		Discharge of heavy metals into the water
LOW CONDUCTIVITY	Discharges into the water	Oil spill
		Low temperature

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LAND USE CONDITIONS

RURAL OBSERVATIONS	POSSIBLE ASSOCIATED PROBLEMS	POSSIBLE ASSOCIATED CAUSES
AGRICULTURAL Crop Production	Chemical runoff — pesticides, herbicides, insecticides	Poor farming practices causing excessive erosion of sediment and chemicals from fields
	Temperature increase in body of water adjacent to agricultural fields	Shade trees and shrubs removed from stream bank for irrigation or agricultural expansion, exposing the water to direct sunlight
	Natural flow of water impeded	Dams, dikes, and diversions for agricultural practices decrease flow rate of water, absorbing more heat from sunlight
	Reduced ability to contain suspended solids, chemicals, and excess water from runoff	Draining swamps and marshes for farmland
Manure Piles	Organic waste entering water from runoff	Improper containment of farm animal waste
Animal Grazing	Organic waste entering water from runoff	Direct discharge from farm animals with access to waterways or waste entering a body of water as runoff
RESIDENTIAL Housing	Excess water and chemical runoff, runoff from fertilized and impervious land	Urbanization leads to increasing numbers of buildings, homes, and roads on lands that previously were natural areas, runoff from driveways and lawn
	Reduction in vegetation shading body of water	Shade trees and shrubs removed from watershed for housing development, exposing the water to direct sunlight and increasing sediment and suspended solids entering a body of water from erosion
Septic Systems and Gray Water Fields	Human wastes and/or gray water leaking into groundwater	Leaking or failing septic systems
	Detergents	Household cleaning agents washing into water and sewage systems
Dumping	Trash	Litter washed into sewer systems
	Organic waste — once part of a living plant or animal (food, leaves, feces, etc.)	Pet wastes not collected and disposed of properly
		Grass, tree, and shrub clippings washed into sewer systems
SCHOOL	Runoff from fertilized and impervious land	Impervious land cover such as sidewalks, play grounds and parking lots causes excessive runoff
	Trash	Litter washed into adjacent waterways or sewer systems
COMMERCIAL/INDUSTRIAL	Reduction in vegetation shading body of water	Shade trees and shrubs removed from watershed for commercial/industrial development, exposing the water to direct sunlight and increasing sediment and suspended solids entering a body of water
	Organic waste	Wastewater treatment plants
		Discharge from food-processing plants, meat-packing houses, dairies, and other industrial sources
		Organic waste from fibers originating from textile and plant processing plants
	Runoff from fertilized or impervious land	Impervious land cover such as parking lots and sidewalks causes excessive runoff
	Industry and power plant discharge	Industrial cooling process; water returned to source body of water is at higher temperature than at initial intake point
		Industrial or mining drainage
CONSTRUCTION Buildings and Roadways	Sediment and suspended solids	Construction of new buildings, homes, and streets causes excessive erosion
		Paved roads cannot absorb chemicals, soil, and suspended particles in runoff
		Draining swamps and marshes for commercial or residential development reduces water catchment ability and filtering of silt and suspended solids
		Dredging waterways
	Temperature increase	Dams, dikes, and diversions for drinking water intake decreases flow rate of water, absorbing more heat from sunlight
PUBLIC USE Zoo	Organic waste	Direct discharge from mammals and birds as waste entering a body of water as runoff
Parks and Golf Courses	Runoff from fertilized and impervious land	Chemical runoff from golf courses and recreational parks entering a body of water as runoff
		Impervious land cover such as parking lots causes excessive runoff
Airports, Bus Stations, Train Stations	Runoff from impervious land	Impervious land cover such as parking lots causes excessive runoff
Marina or Shipping Port	Petroleum products	Chemical pollutants from point or nonpoint source pollution

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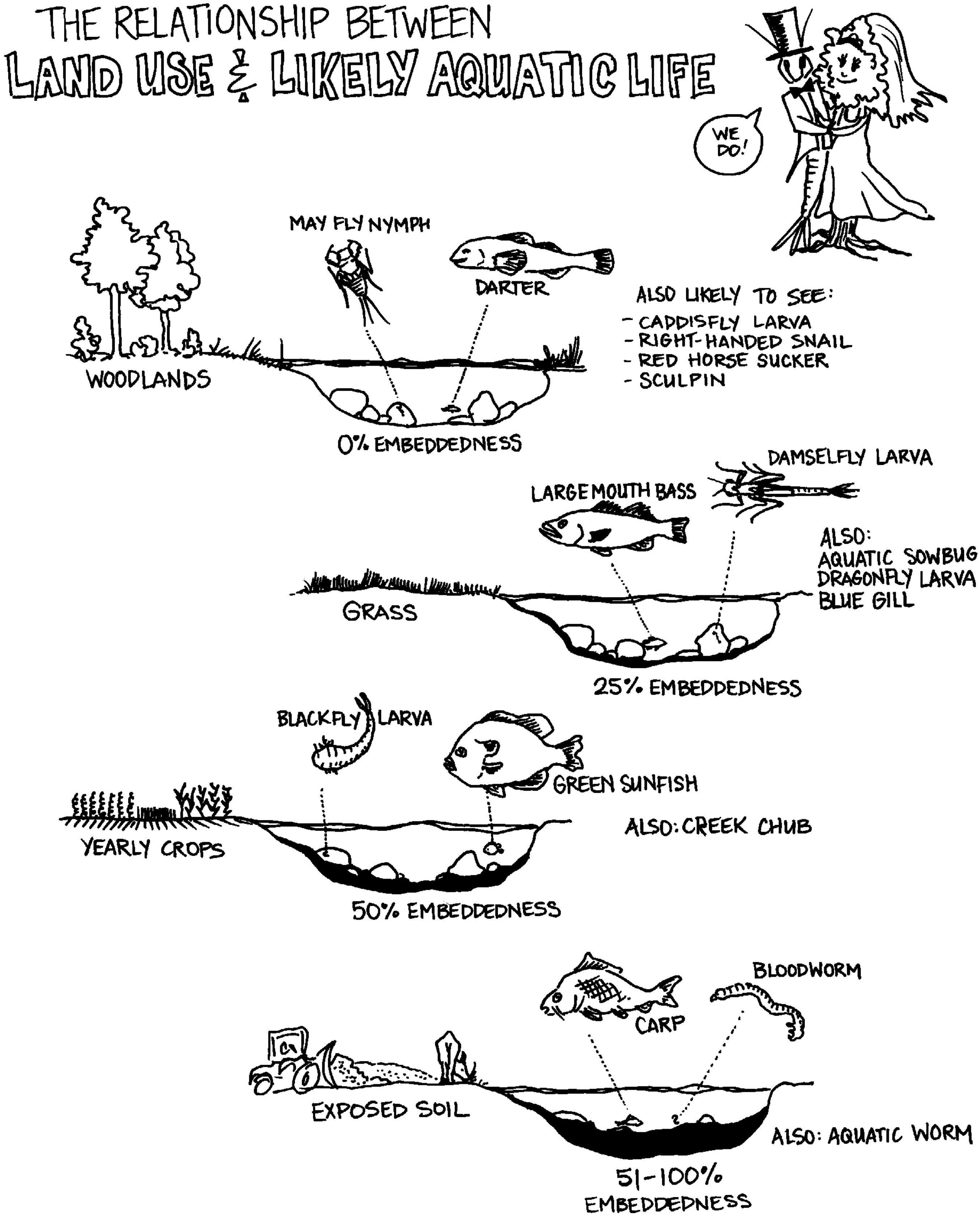
THE RELATIONSHIP BETWEEN
LAND USE & LIKELY AQUATIC LIFE
WE DO!
MAY FLY NYMPH
DARTER
ALSO LIKELY TO SEE:
- CADDISFLY LARVA
- RIGHT-HANDED SNAIL
- RED HORSE SUCKER
- SCULPIN
WOODLANDS
0% EMBEDDEDNESS
DAMSELFLY LARVA
LARGEMOUTH BASS
ALSO:
AQUATIC SOWBUG
DRAGONFLY LARVA
BLUE GILL
GRASS
25% EMBEDDEDNESS
BLACKFLY LARVA
GREEN SUNFISH
ALSO: CREEK CHUB
YEARLY CROPS
50% EMBEDDEDNESS
BLOODWORM
CARP
EXPOSED SOIL
ALSO: AQUATIC WORM
51-100%
EMBEDDEDNESS

REPRESENTATIVE STREAMS

HABITAT & SPECIES DIVERSITY